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ABSTRACT

Several factors have been identified that influence a teachers' use of curriculum materials. This paper focuses on the development of materials as a key factor in this process. Clarification is given on how a sophisticated design of curriculum materials can improve curricular implementation processes and outcomes. An overview of the implementation problems of a curriculum development project for primary science by the Dutch National Institute for Curriculum Development is presented and major problems, symptoms, and study strategies are discussed. The teacher's role as learner, specifically in the initiation phase, is then analyzed. Expectations for teachers are also outlined. A summary follows of a field experiment that was designed to compare and test the effects of use of originally developed curriculum materials with materials that incorporated teachers' needs and suggestions. Differences were found in the nature of the teachers' planning activities and in the students' time on task. The experimental group showed a greater orientation to subject matter content and the didactic process then to logistical aspects and tasks. It was suggested that curricular materials should stimulate teachers to analyze the what, when, how, and why of their own teaching role. (ML)

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THE TEACHER AS A LEARNER IN CURRICULUM IMPLEMENTATION

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1. INTRODUCTION

Three years ago an issue of the Journal of Curriculum Studies (1983, vol. 15, no. 1) was largely devoted to a symposium titled: 'How can curriculum guides guide teaching?'. In an introductory paper, Westbury (1983) once again calls our attention to some difficult problems, formulated earlier by Walker (1980)for writers of curriculum documents:

* How to attain sufficient clarity and specificity so that those who are supposed to be instructed by a curriculum guide know exactly what they are being advised to do.
* How to make a guide easy to consult, attractive, and helpful so that it will be used.
* How to allow for the variety of settings, personalities, and circumstances for which the guide is intended.
* How to maintain the widest possible acceptability so that a guide's proposals, prescriptions, recommendations and suggestions will be followed in a school or community.

Westbury agrees with Walker that there is very little, research-based knowledge available about how to design such products. Yet these questions are very important, "if only because written materials represent, when contrasted to in-service courses, workshops, and the like, a potentially most cost-effective way of influencing teachers" (Westbury, 1983, 2).

The different symposium papers (of Anderson, Harris, Olson) address the questions - understandably - as being of a slightly rhetorical nature. No effort is made to come up with simple, straightforward answers, but each author offers interesting ideas and suggestions from divergent perspectives. A common thread through the papers is the argument that (more) attention is needed for the intentions and practical problems of (individual) teachers in the implementation process. A more deliberate implementation perspective urges one also to keep in mind that many factors can influence the teachers' actual use of curriculum documents. Fullan (1985, 1214) summarizes these factors with the following elements:

- attention to the development of clear and validated materials;
- active administrative support and leadership at the district and

especially at the school level;
- focused, ongoing inservice or staff development activities;
- the development of collegiality and other interaction-based conditions at the school level; and
- the selective use of external resources (both people and materials).

In this paper, we shall focus on the first element: curriculum materials.
Starting from an analysis of implementation problems in primary science education, we shall try to clarify how a sophisticated design of curriculum materials can improve the implementation process and outcomes. The emphasis will be on the early stage of the implementation process (initiation).

2. IMPLEMENTATION OF A PRIMARY SCIENCE CURRICULUM

The context of our research activities is given by a curriculum development project for primary science (Dutch acronym: NOB), initiated in 1978 by the Dutch National Institute for Curriculum Development. The main characteristics of the NOB-project are comparable with those of earlier British and American science projects:
- integration of elements from various disciplines like biology, physics and chemistry;
- emphasis on active forms of learning (especially inquiry learning) and stimulation of 'hands on' experiences with concrete objects.

The first years of the NOB-project were largely spent on small-scale explorations of the possibilities for science education. These activities were carried out in an intensive interaction between curriculum developers and teachers of a limited number of pilot schools. Many of the resulting lesson ideas were published in a project journal. Mainly based on this developmental work at the classroom level, but also on more academic and deliberative activities, curricular proposals for the school and the national level gradually became available.

Dissemination-oriented activities have been extended and intensified in recent years. Some examples: conferences and working parties for large

groups of interested teachers in different areas of the country; special meetings for persons working in pre- and inservice training and local guidance; stimulation of network formation and platform organization; stimulation of 'teachers' center' initiatives.
All these activities are aimed at acceleration and facilitation of a diffusion process. The personal support in the further implementation process can only be delivered by local agencies. For the curriculum developers in a national project, the curriculum materials themselves remain the main vehicle for the dissemination of the developed ideas and proposals. Thus the design problems as stated by Walker are of utmost relevance to them.

Our research at Twente University started in 1982 with an elaborate analysis of the implementation problems in science education.
The activities included:
- study of the existing international literature on the implementation of science curricula (e.g. Welch, 1979; Tamir et al., 1979; Olson, 1982);
- interviews with and questionnaires for teachers (both the ones participating in the NOB-project as well as other groups) and teacher trainers;
- interviews with the NOB-developers;
- document analysis of developed curricular products.

The implementation problems can be summarized as follows (cf. also Harlen, 1983 and 1985):
- great difficulties in changing the didactic role of the teacher, especially regarding the pursued forms of inquiry learning;
- a lack of background knowledge and confidence of teachers in subject matter and skills;
- the lesson preparation is seen as complex and time-consuming;
- an unclear view on and little realization of learning effects with the pupils.

Most teachers expressed a need for a large amount of concrete exemplary lesson materials. The more experienced science teachers showed a preference for materials with a large latitude, while the less familiar teachers preferred more structured and specific materials. The analysis of already available NOB-materials revealed that the materials had a

rather open character with little structure and specification. Most materials had the form of "classroom stories", intended as inspiring examples. The discrepancy reflects a dilemma for the developers. They acknowledge the teachers' need for ready materials, but they doubt if the use of such materials will lead to significant changes in teachers' behaviours and beliefs.

It seems important to keep in mind that the overwhelming majority of the target group consists of teachers who are confronted with two additional problems: a big change is required in their teaching role and, since they have not been involved in the original development process, they start from a non-familiar position. One must also be aware of the fact that the general context for the implementation of new science curricula in schools is not very favourable. Many of the reported problems with school science in the USA (e.g. Yager & Penick, 1983) are also (or even more severely) present in the Netherlands. Several apparent symptoms can be mentioned:

- supremacy of one-sided textbook use;
- very restricted goals (often limited to biology and very few process skills);
- an expository instructional approach (dominance of passive forms like listening);
- low priority for science initiatives, compared with other curriculum areas;
- very little science curriculum planning at the school level.

What sort of functions can curriculum materials fulfill in this problematic area? Some authors seem rather sceptical about the potential of teaching materials in the implementation of primary science programmes. Harlen (1985) shows more confidence in the training of teachers in instructional skills and in personal help within the schools.

We prefer not to think in terms of mutually exclusive strategies, but to search for an effective combination of "product" and "process" approaches. Given the earlier mentioned cost-effective potential of curricular materials, more efforts should be made for a "better" design of those materials so that they can play a more effective role within a broader implementation approach.

A most important condition for obtaining "better" designed materials, is to analyze the role of the main user: the teacher.

3. THE TEACHER AS A LEARNER

Essentially, implementation puts teachers in a process of developing meaning of the innovation for themselves and their students (Fullan, 1982). Changes are required in teaching behaviour as well as in beliefs, attitudes and understanding. Of course, not all these changes can be realized at once; time is a very important factor in implementation processes. It is not uncommon to distinguish between several subphases of implementation and to label these with terms as: initiation, (actual) implementation, incorporation. Here were shall focus on the early stage of implementation: initiation.

The reasons for this choice are:

- the first stage is almost always the most hectic and rough one; feelings of uncertainty and the need for help are predominant;
- for individual teachers the initial experiences are often decisive for their willingness to engage later on in the process; in the context of science education this is very important in view of the weak supporting factors (mentioned earlier) on the school level.

The implementation process involves teachers in a process of learning new roles and unlearning old ones. The initiation phase, when neither familiarity nor prior commitment can be expected, will be dominated by the need for clarification and exploration.

How can curricular materials contribute to this learning process? Which functions can be fulfilled?

Referring to the well-known distinction of different curriculum levels by Goodlad et al. (1979), one might argue that the materials (as a specimen of the "formal" curriculum) should help teachers consider questions as:

- What is the essential meaning of the ("ideal") curriculum?
- How does it relate to my current ideas and practice ("perceived" curriculum)?
- How can I use it in my classroom ("operational" curriculum)?
- How will it influence my pupils ("experiential" curriculum)?

Of course, not all these questions have to be answered at the same time. Some problems will be of a greater and earlier concern than others.

The concept of "developmentalism" (Loucks & Lieberman, 1983; building on work of Fuller, 1969 and Hall & Loucks, 1978) explains that the concerns of teachers about new curricula will develop from more "self-oriented" concerns early in the process to more "task-oriented" concerns as they begin to use it. Later on, when they have gained some confidence in the new procedures, they can focus more on the "impact" of the curriculum on the pupils. Thus, the initiation phase starts with personal, survival concerns. The materials can support the teachers by anticipating as much as possible the potential problems and by offering practical advice to prevent or solve them. By a careful strategy of development, evaluation and revision, the clarity and practicality of the materials must be furthered. With such sophisticated materials it is also realistic to ask teachers to try the materials first "as is" and to make no adaptations beforehand. Once the teacher who uses "role taking" experiences (Sprinthall & Thies-Sprinthall, 1983) has felt the "spirit" of the program, there is less risk for the sort of adaptations that violate the essence of the proposals. This is once more the case if the lesson has been successful, both in teacher performance and in students' learning. These rewarding experiences can lead afterwards to feelings of commitment to the innovation (cf. Crandall, 1983).

Research on teacher planning (see e.g. the reviews of Shavelson & Stern, 1981 and Clark & Peterson, 1985) has raised our awareness of the interrelations between the thinking processes of teachers before, during and after instruction. Although this line of research has not yet led to results which can easily be translated in recommendations for the design and implementation of curricula, it has become more evident that changing the practice of teaching requires more attention for the stage of pre-active planning. We may expect that curricular materials can activate and support the teachers' planning by providing a clear orientation on the teaching task, by pointing the teachers to critical features of the lessons, and by making suggestions how to deal with emergent problems during the instructional process.

Also, more general learning theories underline the crucial function of orienting activities in learning processes. For example the work of the Dutch psychologist Van Parreren (1983) suggests that a more active and

complete orientation to a learning task will increase the chance that more conscious and intentional acting will take place during the task. When orientation results in a more precise and reasoned plan for action, the chances are increasing for a better balance between the learners' own intentions and situational influences. Also the risk of forgetting important elements during the task performance may decrease. Moreover, an intensive orientation offers a better base for control and reflection afterwards. The learner will possess a more precise base for analyzing the process and his/her own role in it. Such metacognitive activities may increase the potential for steering the students' own learning process.

Applying this conception of learning to the position of the teacher (as a learner when confronted with a new teaching task), it seems important that the teacher receives clear directions for orientation to this task. Thus, it seems desirable that curricular materials, intended for the teachers' initial use, contain a large amount of "procedural specification", i.e. very accurate how-to-do-it advice for the acting of the teacher. This advice should be especially focused on essential but apparently vulnerable elements of the curriculum. With the help of such specific materials, the teachers should be stimulated to an intensive task orientation and to concrete role-taking experiences and supported with practical advice for successful lesson operations.
Following these orienting and teaching activities, the teachers may be expected to have

- acquired more clarity about the essential meaning of the curriculum;
- become more familiar and self confident with regard to the teaching roles;
- been stimulated to reflection on the instructional process and their own role in it; and
- been encouraged to first appraisal, commitment, and planning for follow-up activities.

In view of these pursued functions of curricular materials during initial use, we can formulate an important point for attention to the design of such materials for science education. Many "procedural specifications" seems necessary, but not for all curriculum elements.

Excessive specification is inefficient and perhaps even counterproductive. It seems better to concentrate the how-to-do-it advices on the most salient implementation problems of the teachers.

Other suggestions for an effective design of curricular materials can be derived from:

- research literature about the relation between attributes of curricula and subsequent implementation (e.g. Rogers & Shoemaker, 1971; Ponder & Doyle, 1977; Emrick & Peterson, 1978; Crandall et al., 1982; and also the earlier mentioned JCS-papers of Anderson, 1983; Harris, 1983; and Olson, 1983);
- literature about the design of print materials from communication and media perspectives (e.g. Fleming & Levie, 1978; Marsh, 1983); and
- many sources in the extensive literature on science education.

4. CONSTRUCTION AND FIELD EXPERIMENT

The problem analysis described earlier and literature study have led us to a rather elaborate set of assumptions and working hypotheses about potentially fruitful design characteristics for science curricular materials. We have grouped these characteristics around the four apparently most critical aspects of the science curriculum: lesson preparation, subject matter, didactic sequence, and learning effects. For each of these central implementation problems, we described in a most concrete way:

- which functions the material can fulfill for the teacher; and
- which characteristics of the materials are necessary for those functions.

In search of possibilities for an empirical testing of our working hypotheses, we followed the procedure which is limited to a brief overview in this paper.

Construction

From already available curricular materials of the NOB project some lesson material was selected (by developers and researchers together).

The lesson was seen as representative of the science approach and the material as typical for the usual format. It was a lesson of two hours, centered around building activities and intended for the upper level of the primary school (age 9-12 years). An attempt was made to apply the list of "design specifications" on this lesson material. Special attention was given to the "procedural specifications" of the teachers' actions.
The first draft of this experimental material was evaluated in try-outs with 3 teachers. On the basis of these experiences the material was revised. The emphasis of the revision was on the incorporation of the teachers' perspective (problems, needs and suggestions) in the material.

The next series of try-outs with 7 teachers led only to minor changes in the material and was more intended as a preparation for the research procedure and data collection methods in the field experiment.

Field experiment

In '84-'85 we organized a field experiment to compare and test the effects of the transformed (experimental) material and the original material of the developers, which served as control version.
A random sample of 40 teachers (interested in, but not familiar with the science approach) was divided at random in a group of 20 teachers who used the experimental material and a group of 20 teachers which used the control version.
Each teacher received the lesson material one week before a scheduled lesson date and prepared a lesson independently for her/his own class.
The data collection methods consisted of: video registration and direct observation with note taking during the lesson; semi-structured interview and a short questionnaire after the lesson. The data-analysis was aimed at two issues, both seen as criteria for (more) effective implementation:

(i) To what extent are the lesson activities in accordance with the developers' original intentions?
To measure this outcome we developed, in close interaction with the curriculum developers, a "curriculum profile" of the lesson. In this profile the most essential components of the lesson were described in

various possible configurations with a differentiation between "ideal", "acceptable" and "unacceptable" levels. The final profile contained 34 of such operational descriptions. By a weighing process a numerical value was assigned to each description.
This curriculum profile was then used as a checklist to draw up a "user profile" for each lesson, based upon the actual lesson data by means of the videotapes and notes. This way of scoring resulted in quantitative implementation measures for all the 40 lessons, as seen from the perspective of the developers.

(ii) How does the teacher perceive the lesson and what are her/his own learning results?
The information about this teachers' perspective was gathered by coding and analyzing the interviews and questionnaires. Although also teachers' comments were collected on the material itself, the general lesson process, the functioning of the pupils and such, most attention was given to the role of the teachers themselves. How did they plan their lesson, what was their perception of their own teaching role and what were their post-instructional reflections on the curriculum proposal and their own attitude toward it?

5. RESULTS

This paragraph offers a short description of the results of the field experiment. (More information can be found in Van den Akker, 1985 and forthcoming publications). After mentioning the main results on the first criterion for effective implementation (the user scores on the curriculum profile), we shall focus on the teacher reports about their planning activities and their reflections about their own role.

The "user-profile" scores in the experimental condition are much higher than those of the control group, as can be seen in the following results:

	N	Mean	SD	T	P
Control	20	44.65	17.27		
				- 6.96	<0.001
Experimental	20	78.70	13.42		

The differences are not only quite clear for the complete profile (possible maximum: 100), but also for each of the four components of the profile.

Because the profile scores are especially related to the behaviour of the teachers, it is also interesting to mention a result which is immediately related to the students' functioning during the lesson. There appeared a large difference between the "time on task" as spent by the pupils. In the experimental group they spent about 50% more time on active learning at their building tasks.

Given these large differences in the lesson process between both conditions, it is interestering to pay extra attention to the teacher reports about their lesson planning activities.
Although the time needed for lesson preparation appeared to be almost the same for both conditions (about 2 hours on the average), the nature of the planning activities was very different. In the control group most time was spent on logistical aspects (materials collection and such), while teachers in the experimental group oriented themselves much more to the subject matter content and the didactic process of the lesson. This different emphasis showed itself in divergent ways of planning, as summarized in the next scheme:

planning activity	control group	experimental group
reading of lesson material	quick and global	concentrated and iterative
self preparation on pupils'building tasks	hardly any efforts	majority does own try-out
written planning	very few notes (besides on group distribution)	very frequent notes, including lesson structure and attention points

Some other points of difference between the two conditions:

* Teachers in the control group often reported problems regarding the subject matter (lack of understanding, uncertainty), while the experimental group was positive in this respect.
* Although both groups seem to be aware of the intended inquiry approach of the lesson, their perception of their own role is quite different. Teachers in the control group often reported that they deliberately have taken a withdrawn, passive role (in fact resulting in a sort of "laissez faire" attitude). Teachers of the experimental group report often that they saw it as important in their role to offer active guidance in the discovery process of the pupils. The teachers of the experimental group also formulated many more learning experiences about their own teaching role.
* Teachers in the experimental group also reported more frequently and explicitly than those of the control group:
  - that the lesson experience was different from their "routine" approach;
  - their satisfaction about the lesson material, the lesson process and the performance of the pupils; and
  - future-oriented conclusions about their own teaching role.

6. DISCUSSION

A recurrent theme in discussions about curriculum innovations refers to the question of whether curricular materials, intended for a large target group, should have a more "open" or more "structured" nature. Probably, at this point no general assertions are possible. However, if one considers initial implementation efforts, our research findings suggest that a structured approach is more effective. It seems possible that curricular materials can lead to aims which are often seen as hard to combine:

- realization in practice of the developers' intentions with a high degree of "fidelity";
- stimulation of a change process in teachers' thinking about a curriculum innovation and their own role in it.

In both conditions adaptation processes occurred, but they were of a

different kind. The control group adapted the lesson proposal more or less to their own routines (a sort of "assimilation"), while the experimental group followed the lesson proposal remarkably closely and adapted their own role (a sort of "accommodation").
We presume that this tendency corresponds narrowly to the initial use experiences by teachers who are not yet familiar with the new science approach. It seems plausible that at later implementation stages the adaptation of the curriculum proposals will increase. One may yet expect that such adaptations to their own habits and preferences will occur on a more deliberate way, if prior experiences were conducted according to the intended approach. And certainly, if those experiences have been satisfying and yield positive results, there seems more chance on stable and substantial changes in the direction of the proposals for innovation.

Hameyer (1986) recently argued that the initiation phase of an implementation process should be characterized by a "learning-by-trying-out-strategy-element". Such an element can "provide occasions for the user to practice the new tentatively, to recognize important implications and to contribute personally in a way which is not totally anticipated. Effective learning about the new should therefore be facilitated,...." Of course, written curricular materials can never be sufficient to realize all the pursued functions in the implementation process. Nevertheless, this research suggests a high degree of effectiveness in starting up the learning process, when the curricular materials stimulate the teachers to a more elaborate and accurate "internal dialogue" about the what, when, how and why of their own teaching role. The "procedural specification", as applied in the experimental materials, seems to be a good device for that purpose.

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